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### 3. LEARNING FROM TEACHER THINKING

*An Insight into the Pedagogical Complexities of Scientific Literacy*

Scientific literacy is a new consideration in the teaching of science and for teachers it raises many questions: what does scientific literacy mean particularly in terms of student learning?; How is it evident in the classroom?; and, Will it require changes to present planning, teaching and assessment practices? Many of these questions can only be answered by teachers themselves as they explore these issues in their practice. Yet the teacher's voice has been noticeably absent from the present debate about the merits of promoting scientific literacy as an outcome for students. This is regrettable because teachers have a significant contribution to share in terms of understanding and developing this new vision for science education.

The very nature of teacher expertise lies in the ability to shape meaningful student learning within a constantly changing, consistently complex and often ill-defined professional context. This is particularly true with science curriculum which has been reinterpreted by teachers, in particular primary teachers, in ways which enable them to access, think about and work with content to enhance student learning. This process is not only challenging but increasingly important for teachers when their personal confidence is continually compounded by an ever expanding and increasingly demanding science curriculum. Therefore working in the role of critical friend with the teachers from Our Lady of Good Counsel (OLGC) has been an exciting experience for me because this is a project which acknowledges and values teacher professional experience and the many important insights teacher professional knowledge offers about student learning.

Throughout this project I have had the privilege of encouraging the OLGC teachers to examine and share their thinking and their experiences as they explore new learning in science. I have worked closely with the teachers in ongoing meetings to plan the early stages of unit development, clarify the big ideas to be explored in each unit and develop the related understandings that will guide their teaching. During these meetings I have attempted to ask some difficult questions about planning and teaching and tried to ascertain each teacher's motives and reasoning for their professional decisions; particularly the knowledge they call on when they are faced with planning dilemmas: How do they decide what actions are the most appropriate?; How does working to promote scientific literacy influence these decisions?; What indicators do they use to determine if the implemented approach has the desired impact on student learning?; and, Have observations of student learning behaviours

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changed since the project began?, to list but a few. I listened to the many ways teachers connected this thinking to their selection of student learning experiences and how this thinking determined their judgments of progress.

We have taken time at the completion of each unit to reflect on the teaching and learning successes and to identify the areas that have emerged as problematic. We have shared our thinking, dissected our practice and stretched our professional expertise in an attempt to unravel some of the pedagogical complexities associated with constructing an understanding of scientific literacy in the classroom. In doing so, some important considerations have emerged in relation to teacher professional learning and pedagogy and I believe that these contribute new perspectives to the scientific literacy debate.

#### VALUING TEACHERS' PROFESSIONAL KNOWLEDGE

When the teachers at OLGc began to consider scientific literacy as an outcome for their students, it was amidst the everyday intensity of an already busy and demanding teaching role. The demands and time constraints were the same as those faced by many other teachers. However, these teachers were offered an additional type of support because the school leadership team made a point of noticing the busyness of their teaching routines and attempted to create some internal support structures that might provide time and assistance for them to think about their practice. The role of 'critical friend' and regular designated planning session times, where teachers worked in teams, were two of these support structures.

At OLGc these planning sessions were valued by the leadership team as an important opportunity to encourage teachers to notice and rethink the issues underpinning their practice. Teachers were released from their classroom teaching duties for two ninety minute sessions each term and were able to sit and work with me (critical friend), the school based Teaching and Learning Coordinator and other teachers who were working at the same grade level within the school.

These sessions were about finding ways to remind teachers to notice the possibilities and opportunities for alternative thinking and action within their regular classroom teaching routines. These meetings aimed to provide professional support so that teachers might be more likely to think about what scientific literacy meant, and as a consequence, notice opportunities in their teaching to consider the implications of these ideas; even if it meant finding alternative ways of working and thinking about their practice.

For most of the project I worked alongside the school's Teaching and Learning Coordinator and we discussed the challenges of preparing for, recording, recognizing and assessing teaching aimed at promoting scientific literacy. We listened to each other's personal reflections as well as those of the teachers and we observed first-hand the frustrations they experienced as they tried to rethink learning and the structures which traditionally defined their practice. Not only did these planning meetings provide an opportunity for teachers to participate in professional learning (from and with each other; sharing ideas and learning together), but they were also a powerful professional learning experience for each of us.

## PROFESSIONAL LEARNING: SUPPORTING TEACHERS TO NOTICE

In an ideal world as professionals, we would notice and be aware of everything that is going on around us all the time as well as what we are thinking in the moment. However, the reality is, particularly in the classroom, that the pace of activity is intense and demanding so it is often hard for teachers to notice why and how they act in the way they do. To develop meaningful, personal professional practice requires an intense degree of self-awareness and noticing in order to make informed choices about to how to act in the moment, and how to respond to situations as they emerge (Mason, 2002). Even with the best intentions, noticing is not easy, and that difficulty is compounded when also trying to do something different.

As education professionals the teachers at OLGc constantly made deliberate decisions about how to respond to their students' needs in the classroom, yet because such thinking is fundamental to practice, they often didn't notice the nature of their decision making in action. To really understand the implications of developing scientific literacy as part of their classroom teaching, it was important that these decision making processes be made explicit and this required a level of self-awareness that was neither expected in their normal practice, nor particularly evident early in the project. Therefore, we decided that one of our roles (myself and Teaching and Learning Co-ordinator) in these planning meetings was to support teachers to recognize the rich range of possible actions and strategies they were developing and using in response to the new learning that was taking place. We needed them to articulate their thinking in order to access the pedagogic dilemmas they were managing in their classrooms. We therefore saw a need to encourage and 'give permission' for teachers to talk through, and actively respond to, the new and different learning opportunities they experienced as they emerged.

## BUILDING TEACHER CONFIDENCE

To develop professional self-awareness requires trust and strong personal relationships. To establish these relationships we spent a great deal of time listening. Rarely did our voices dominate the planning sessions, we deliberately attempted to encourage teachers to talk and take ownership of the planning process rather than sitting passively and expecting to have their problems solved. Listening helped us notice that each teacher was different and that what each considered appropriate depended on what they valued which in turn affected what they noticed about their practice (Mason, 2002).

Listening allowed us to hear each individual teacher's priorities and use these to define some shared goals and understandings. We then tried to reiterate these priorities so that they were able to hear their own voice, recognize their own language and notice that their ideas were valued. In time they also came to notice aspects of their own practice in ways that enabled them to evaluate their actions against these goals.

The teachers constantly experienced frustration as they tried to change the ways they worked. This was at times uncomfortable to observe and it was often difficult for us to determine how best to respond or support them through these difficult times. Over the past two years we came to realize that although these frustrations were initially problematic they were also extremely valuable in terms of each teacher's

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professional learning. Together we established a mutual understanding that our role was not to 'fix' these problems but instead to find ways to remind the teachers that the answers were most likely embedded within their own professional knowledge.

As our role developed, we came to a position that allowed us to give these teachers 'permission' to work with their thinking and their ideas and to provide the time and space for each to explore their preferred approach, explain their thinking and share their experiences. This meant building teachers' confidence in ways which encouraged them to share openly and professionally in searching conversations about teaching and learning. Although at times robust and sometimes uncomfortable these conversations always aimed to improve the teaching and learning of science and tried to define more clearly what scientific literacy offered students in terms of their learning and their future.

Over time teachers began to understand that we trusted them and had faith in their capacity to make appropriate decisions about their practice in their classrooms. In turn, they trusted us and were willing to talk and share their ideas and concerns without fear of criticism or judgment.

#### THE ACT OF LISTENING TO NOTICE

My experiences and observations as critical friend have reinforced for me the belief that powerful professional learning resides within teacher conversations. However, in my role, listening to words was not enough. Listening had to be about noticing the professional thinking which underpinned the words or expressions teachers used when they shared their stories. This noticing became the most important skill in facilitating teacher professional learning in these planning sessions because often the most powerful and enabling opportunities for these teachers to rethink their practice were embedded within their own conversations, hidden amongst the 'noise' of the talk that surrounded planning and classroom management. Within these conversations there were moments in which it was possible to hear beliefs about scientific literacy that were driving each teacher's practice, what that meant in terms of what they valued in their teaching as well as their vision for meaningful learning.

Sometimes this thinking materialized as tensions which arose in decision making. These were the times when teachers became frustrated and talked about being stuck or lost, or when they said they didn't know what to do next. At these times they experienced difficulties as they attempted to draw on the wisdom encapsulated in their collections of professional responses, their repertoires of options, which they had developed over time and which formed the basis of their professional expertise. In the past these options had reliably guided their decision making but now the existing repertoires appeared inadequate because in some way they had started to see science education differently; they had started to rethink what meaningful learning looked like and the nature of the conditions that they now saw as necessary for enhancing such learning.

Across the project a new framework for learning began to emerge. In time that framework created new concerns about practices and approaches that had previously not been noticed or simply overlooked. Their new thinking challenged each to change the ways in which they worked and that in turn led to changes in the ways their

students worked. With a new frame of reference the previous indicators of student learning, which were familiar, were not always so noticeable. Instead, a number of new and unanticipated events began to replace that which once was. Initially, those events, although informative, in the chaos of the moment were not immediately noticed and the potential of these unexpected events therefore were not so readily recognized. At these times, to facilitate professional learning, together (myself as critical friend and my colleague the Teaching and Learning Coordinator) we worked harder to listen, notice and assist all of our teachers to notice, recognize and attend to these new events.

#### AN EMERGING FRAMEWORK FOR LEARNING: THINKING DIFFERENTLY ABOUT UNIT PLANNING

A very powerful example of this new thinking occurred in the first year of the project and in time led to some significant changes in the ways teachers began to think about and implement their actions in relation to unit planning. In a level planning meeting with teachers from the grade three area, one teacher expressed dissatisfaction with the time that she was able to devote to one particular unit of work. Her comments drew attention to some very interesting obstacles for learning and raised an issue that teachers had subconsciously accommodated for some time in their practice. However, now it was more significant because they were all actively rethinking the type of conditions which would effectively contribute to promoting scientific literacy as an outcome for student learning – what they noticed and why was clearly changing:

*Teacher 1: It is such a shame that we have to close this unit (Topic: 'Relationships') and move on to the next. The children were just really beginning to enjoy this topic but Term 1 is nearly finished and we have to start the new unit next term. (Field notes from meeting)*

In this meeting I heard what these teachers were saying about moving on to a new unit; the regular routines, the term structures and compliance with an accepted planning routine. However, I listened instead to the tension that was underpinning these comments. It was a tension about time constraints and the impact these had on learning. There appeared to be some discrepancy between what teachers said they valued, that is the importance of providing time for learning, and what they were actually doing; imposing definite time constraints on how and when students engaged in learning experiences.

It was only when the teachers at OLGK started to consider scientific literacy as an outcome for their students that this approach to planning became problematic for them. Their planning practice was typical of the accepted approach in most primary schools in which teachers traditionally plan inquiry based units of work which attempt to meaningfully integrate a number of curriculum areas in the hope of encouraging students to draw on a range of skills and understandings. These units were taught and developed across a school term (on an average ten week time block). At the end of each term the unit concludes and preparations begin for introducing a new unit the following term. The new unit is often totally unrelated in terms of content and knowledge to the previous unit. However, as indicated in the above transcript,

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these teachers had changed some of their approaches in the classroom and were beginning to see a different level of student engagement taking place. As a result the idea of finishing a unit and abandoning the potential learning now presented a new challenge; a challenge not so readily recognized in the past.

As teachers started to develop personal beliefs about scientific literacy, that is what they valued in their teaching and their vision for meaningful learning, they became increasingly concerned that their existing planning and teaching practices might actually be contributing to ‘disconnected’ student learning. They were beginning to question whether their students were leaving their thinking and ideas behind as they moved on to new units; never really exploring the potential of their ideas and thinking in a unit as they were pushed towards a different topic. I noticed that these teachers appeared to be voicing a view that student motivation and interest was being sacrificed at the expense of ‘getting through’ the curriculum; this again was now becoming problematic. However, this tension created new possibilities for planning.

#### EMERGING NEW IDEAS

*My main concern from this meeting was the view expressed that time was working against effective teaching of this unit and that the work that was started would now be left behind when heading into the next unit. This got me thinking about how it might be possible to see if the year’s units might all link together in terms of the understandings embedded in each. I decided to play with this idea in an attempt to visually represent how the teaching of one unit could effectively contribute to the understandings developed in another unit. (Field notes from meeting)*

After this meeting I went away and developed the ideas displayed in [Figure 3.1](#).

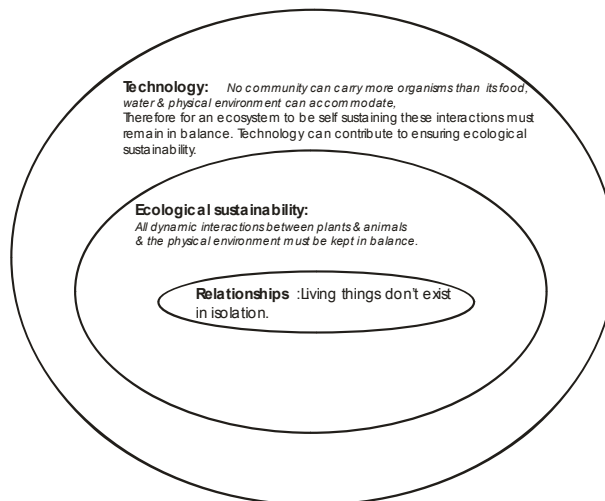


Figure 3.1. Interconnections of planning across topics for the year.

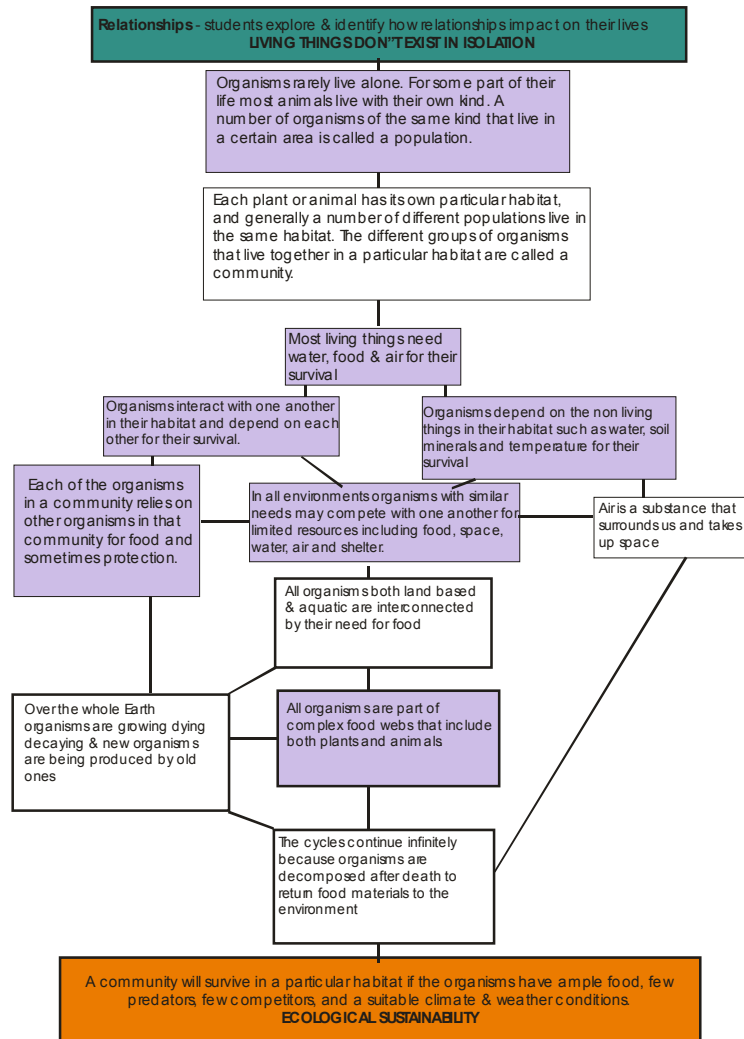


Figure 3.2. Relationships and ecological sustainability (Adapted from DEECD, 2006).

By developing this diagram in my field notes I was trying to conceptualise an alternative way of thinking about planning which might enable teachers to see that they had options, that it was possible to think differently about their planning and teaching routines.

I began to explore the idea that perhaps the unit at the beginning of the year, in this case ‘Relationships’, introduced ideas and thinking that had the potential to flow out to the following units across the year, that is ‘Ecological Sustainability’ and

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‘Technology’. As this thinking represented a very alternative approach, I decided that it might be useful to represent these ideas visually. The diagram (Figure 3.1) became a way of explaining this approach as a ripple effect for learning, just as in a pool where a stone is thrown in the middle and the waves radiate out from the centre. So too learning could start and potentially develop more broadly.

The idea of linking units seemed to offer a useful alternative framework from existing planning structures but it required very clear statements outlining the big ideas of each unit. I was of the view that once this information was clarified it might be possible to consider if there were links across the ideas. Exploring the possibility of how the big ideas of each unit might link together in some way was an important way of ensuring that students’ learning stayed alive; that they valued what they learnt and did not see their thinking connected or limited to only one unit.

The challenge of exploring possible connections across topics was compounded by the need to work on different understandings for different grade levels within the school, i.e., deciding what was age appropriate and also what was of interest to the students at each level. This required some brainstorming of possible ideas and again I continued to explore resources and ideas to determine possible connections and tried to represent these in some visual way (see Figure 3.2, ‘Relationships & Ecological sustainability’).

#### MAINTAINING TEACHER OWNERSHIP

I presented my thinking and diagrams to the staff and we engaged in discussions about the strength and weakness of this approach and the inevitable challenges which were likely to emerge. The diagrams not only showed that we had some new options for planning but also highlighted the limitations of our present planning routines. The feedback was interesting with some teachers seeing immediately the value of keeping student learning alive in this way while others were hesitant.

Even though many teachers could see the merit in these ideas the immediate shift in thinking was too great and too challenging to implement immediately. It was important that the ideas be seen as possible options not as solutions, and most importantly, ownership and decisions about how to move forward had to reside with the teachers themselves. It was not something to be imposed by others.

For some time unit planning continued in the familiar ways but it was becoming increasingly obvious that teachers were seeing inadequacies with that planning approach. They commented that they felt they were not only leaving student learning behind at the end of each unit but that they were also planning too much content and did not have sufficient time to support students to really develop a depth of understanding. Another concern evolved around thinking skills.

It became apparent that in each unit there was not enough time for students to practice and develop the range of thinking skills that teachers were beginning to value as a fundamental aspect of scientific literacy. Teachers were voicing concerns that scientific literacy required each student to develop a particular type of critical thinking and they were seeing the need for teaching and learning experiences that worked towards ensuring that aspects of that thinking be continually practiced, developed



and refined. Students' thinking then needed to be seen as something that habitually recurred so that for each student it was intrinsically embedded in their way of seeing the world. This type of thinking needed to be at the heart of the nature of the learner no matter what the content or the context of the learning. Disconnecting the learning between units was now increasingly being seen as disconnecting the development of this approach to thinking.

Finding common learning and ideas across units began to be seen as a new opportunity for teachers. It was a way of ensuring that opportunities were provided to develop a depth of learning while also developing students' critical thinking skills. We observed that teachers were attempting to find ways and strategies for revisiting experiences from past units.

What we saw happen overtime was a gradual yet decisive move by these teachers towards linking units. How they went about this differed for each level but knowing that they had 'permission' to explore this idea was extremely important. Eventually teachers were initiating more conversations about planning for linking until eventually, in their teams, they were discussing planning with the whole year in mind rather than attending to separate unit titles. This approach required them to consider all the selected unit topics across a year as one body of work, and to identify the key understandings for each and how these understandings could be mapped as inter-related connections across all units. This was a dramatic change to the traditional approach to planning.

Planning began to focus on creating conditions through which it was more likely that students would revisit and rethink their previous experiences in light of new information and key concepts. This view of ongoing learning fundamentally differed to previous well-accepted planning practices in primary schools. The change was in essence in response to the question: "How will you keep the learning alive?" That question became a very powerful way of challenging teacher thinking in relation to finding new planning practices.

#### SHARED UNDERSTANDINGS: THE RELATIONSHIP BETWEEN PROFESSIONAL LEARNING AND PEDAGOGY

'Action' was a phrase that teachers used repeatedly in these planning sessions, initially it was a term used to refer to a product at the end of a unit of work. However, over time we noticed that the use and intended meaning of the word subtly changed. A focus of our work centered on encouraging teachers to articulate what they meant by the place and purpose of action in unit planning. They discussed how action could be: a product; a type of thinking; a process of developing understanding; an opportunity for students to use and apply their learning in practical ways; and, an opportunity for both teachers and students to forge relationships with expertise beyond the classroom, enhancing the range of learning experiences students could access.

These ideas about action also represented to us the type of professional thinking in which these teachers were engaged. Their thinking was purposeful, it was aimed at understanding, and it was directed toward building very powerful professional relationships. The ideas they were sharing were exciting and innovative and some

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strong shared understandings emerged in relation to planning and pedagogy. Through feedback, these were the areas teachers themselves identified that required fundamental changes in order for them to promote scientific literacy as a learning outcome for their students. Within these areas a number of fundamental actions emerged which guided what these teachers actually did in their classrooms. For example, planning\* included:

- taking ownership of and feeling empowered to shape models of inquiry planning to meet specific teaching needs;
  - confronting personal ideas and beliefs about science;
  - recognizing and attending to the big ideas of science;
  - recognizing and building on student input;
  - providing sequential learning experiences particularly in terms of linking the learning across units;
  - taking simple ideas but providing a depth of learning; and,
  - finding links in learning to community and taking action in meaningful ways.
- Aspects of pedagogy\* that were seen as important included:
- clarity of purpose in teaching;
  - responding to students learning needs and interests;
  - promoting rich questions from students;
  - accessing and effectively using a variety of contemporary resources and experts;
  - promoting student thinking, curiosity and imagination; and,
  - engaging students in meaningful contexts for learning. (\*All derived from teacher feedback sheets)

Overtime the teachers clarified a new purpose for science teaching and my observations confirmed for me that the process of promoting student learning was now more engaging and also increasingly recognized by all as more complex. These teachers confronted their existing understandings, perceptions and beliefs about science and considered how they might shape the type of learning experiences they created for their students.

As these teachers worked through this process they developed some interesting alternative perceptions about planning units and the types of learning experiences which they now value but once were not identifiable on the pedagogical horizon. These new ideas, at times were challenging and risky, yet overall yielded some impressive examples of meaningful student learning and have been more than enough to inspire them to continue the pursuit for the development of scientific literacy in their classrooms.

#### SCIENTIFIC LITERACY: WHAT HAVE WE LEARNED?

The mark of an expert is that they are sensitized to notice things which novices overlook. They have finer discernment. They make things look easy, because they have a refined sensitivity to professional situations and a rich collection of responses on which to draw. Among other things, experts are aware of their actions in ways that the novice is not, whether teaching, researching, attending meetings, administering, supporting colleagues, or preparing for any of these. (Mason, 2002, p. 1.)

This project has not only introduced the voice of the primary school teacher into the scientific literacy debate but has also recognized that when provided with appropriate assistance and time, teachers most certainly have the capacity to notice their actions and use their professional thinking to reshape and redefine the purpose of science education within their given context. This is a slow process and relies on recognition of their ability to make informed and appropriate professional decisions about meaningful teaching and learning.

I have noticed how these OLGC teachers' teaching for scientific literacy is far more than teaching science as typically outlined in curriculum documents; it is more than linking learning to everyday events or using contemporary technology to simulate and explore science concepts. Scientific literacy is about a holistic approach to teaching, it is about developing the whole person, it is about nurturing in each student a noticing of life and natural phenomena. Scientific literacy is about fostering curiosity, a willingness to question and an intrinsic need to seek understanding.

Teaching for scientific literacy requires careful, flexible planning, bringing together knowledge of the subject and knowledge of the learner to create a learning environment that builds student interests and explores the learning potential of contemporary events and issues. For the OLGC teachers, accessing, experiencing and talking about science ideas is no longer enough in their teaching. These teachers in different ways and to differing degrees have gone further and shared intellectual control with their students (see Mitchell & Mitchell, 1997 for a full description) and empowered them to make decisions, form their own opinions and apply their understandings in ways that are meaningful to their context and areas of personal interest.

The observations I made and the experiences I have had the privilege to share at OLGC have shaped my understanding of the type of professional support needed by primary teachers as they work through the practical challenges and dilemmas of attempting to rethink and reshape the purpose and meaning of primary school science. It has been my pleasure to work with and learn from the professional thinking and expertise of this committed and determined group of teachers. I am of the view that we as educators must begin to listen and notice teachers' thinking because we have much to learn from them; not only about what scientific literacy means but also the pedagogical complexities associated with implementing this alternative vision for science education.

From working with the teachers at OLGC and from reflecting and trying to make sense of all the experiences we have shared together, I am now able to conceptualize and articulate my personal understanding of scientific literacy, and just like the teachers with whom I have worked, I have started to notice how this now frames my thinking and my actions regarding science teaching and learning.

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